Ultrafast Na Intercalation Chemistry of $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ Nanodots Planted in Carbon Matrix as a Low Cost Anode for Aqueous Sodium-Ion Batteries

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S1 Experimental section

The $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ material was synthesized with a simple sol-gel route. In specific, a precursor solution was firstly prepared by dissolving 0.6890 g citric acid ($C_6H_8O_7{\cdot}H_2O$, 99.5%), 0.5296 g manganese acetate ($Mn(CH_3COO)_2{\cdot}4H_2O$, 99%), 0.7090 g sodium acetate (CH_3COONa, anhydrous, 99%), and 1.4912 g ammonium dihydrogen phosphate ($NH_4H_2PO_4$, 99%) in 30 ml distilled water and then dropping the isopropyl titanate ethanol solution consisting of 2 ml $C_{12}H_{28}O_4Ti$ (95%) and 3 ml CH_3CH_2OH (99.7%). After being sufficiently stirred, the precursor solution was evaporated at 75 °C until a gel was obtained, followed by drying the gel at 100 °C overnight. The resultant powder was treated at 450 °C for 4 h and 600 °C for 8 h in Ar-fluxing atmosphere.

X-ray diffraction (X'Pert Powder with a Cu Kα radiation source) was employed to confirm the crystal structure of the as-synthesized material, and the XRD pattern was recorded in the range of 10-70º with a scanning rate of 8º min^{-1}. The morphological properties were observed with scanning electron microscopy (JSM7500F) and transmission electron microscopy (JEM-2100). The practical composition involving element ratio and carbon content was determined by combining energy-dispersive spectrometer and thermogravimetric analysis (STA449F3, NETZSCH) with a heating rate of 5 °C min^{-1}.

Electrochemical measurements were carried on a three-electrode system with NiHCF counter electrode, Ag/AgCl (saturated KCl) reference electrode, 6 M $NaClO_4$ aqueous electrolyte and prepared working electrode. The working electrode consists of 70 wt% active material ($Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$), 20 wt% Super P carbon and 10 wt% PVDF binder. The loading of the active material in electrode is about 2.5 mg cm^{-2}. The cyclic voltammetry was carried out on electrochemical workstation (CHI 600E) in the potential range of -1.0 and 0 V, while galvanostatic charge/discharge tests were performed between -1.0 and 0 V on Land Test System (CT2001A). In this work, the specific capacity is calculated based on the active $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$.

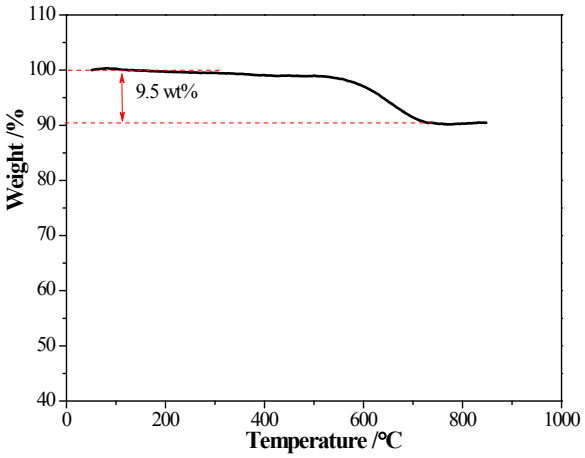

Figure S1. TG curve of the $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ material in air.

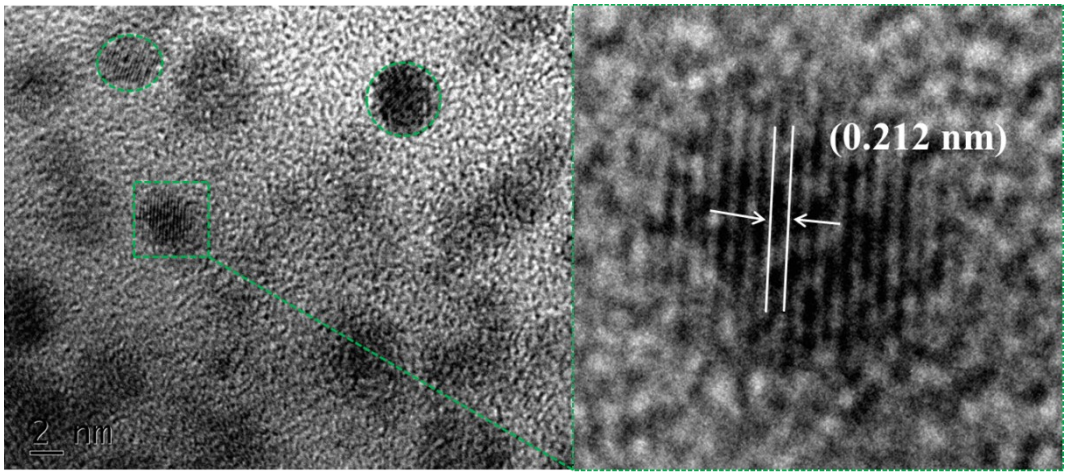

Figure S2. HRTEM images of the $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ material

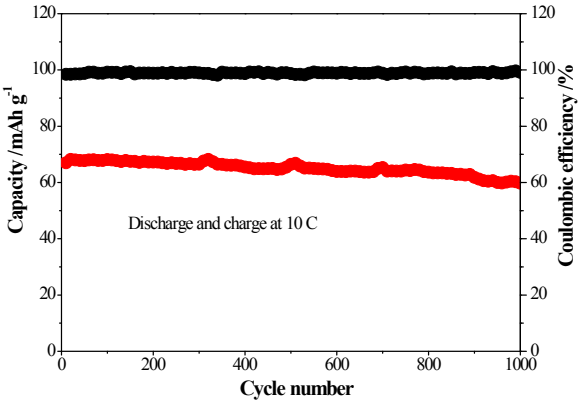

Figure S3. Cycling performance of the $Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ material at 10 C.

Table S1. Performance comparison of reported anode materials for aqueous SIBs.

Material	Reversible capacity	Capacity retention
$NaTi_2(PO_4)_3$[1]	~105 mAh g^{-1} at 1 C	86% after 100 cycles (1 C)
$Na_3MgTi(PO_4)_3$[2]	54 mAh g^{-1} at 0.2 C	94.2% after 100 cycles (0.5 C)
$Na_3MnTi(PO_4)_3$[3]	58.2 mAh g^{-1} at 0.5 C	~97% after 100 cycles (1 C)
$Na_2TiV(PO_4)_3$[4]	52 mAh g^{-1} at 1 C	94% after 500 cycles (5 C)
$Na_2Ti_{3/2}Mn_{1/2}(PO_4)_3$ (this work)	78.8 mAh g^{-1} at 0.5 C	93% after 200 cycles (1 C) 90% after 1000 cycles (10 C)

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